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Accelerated extractions of North Atlantic cod and herring, 1520–1790

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Abstract

We propose the concept of Accelerated Marine Extraction to signify two periods when rapidly increasing cod (*Gadus morhua*, Gadidae) and herring (*Clupea harengus*, Clupeidae) fisheries, c.1540–1600 and c. 1730–1790, exceeded human demographic growth. Total landings vastly exceeded previous assessments and more than doubled between 1520 and 1620 from about 220,000 metric tonnes (t) to 460,000 t. Supplies of cod and herring to the European market peaked in 1788 at more than 1 million t before the unrest connected with the French Revolution brought many fisheries to a temporary halt. Accelerated Marine Extractions increased European food security at times of human demographic growth by almost doubling the supplies of fish protein per capita. While herring was the most important species by 1520, cod dominated through the period 1540–1790, and the trajectories of cod and herring extractions differed significantly. Cod landings increased almost ten-fold between 1520 and 1790, driven by strong and sustained landings in the Northwest Atlantic. Herring landings remained stable through the 16th century but declined severely through the next 150 years. However, from 1750, herring landings quadrupled, largely because of Swedish west coast fisheries. The results fundamentally shift our understanding of the scale of Atlantic fisheries in the past and underline the role of marine resources for European societies.

KEYWORDS

life below water, marine environmental history, North Atlantic, per capita consumption, pre-industrial fisheries, shifting baselines

1 | INTRODUCTION

By c. 1990, worldwide captures of marine fish reached the limit of what the oceans could provide, given the extractive methods currently available and the limited nature of all marine living resources. The majority of fish stocks globally have since been either fully exploited or over-overexploited (FAO, 2020). During the last millennium, European marine fisheries have risen in five distinct temporal steps, around 1000 AD, after 1500 AD, after 1750, again after 1880 and lastly after 1950. Archaeologists understand the first step as the *"fish event horizon,"* indicated by a rise in volumes of marine fish bones in human settlement sediments around Northwest Europe (Barrett et al., 2004; Clavel, 1997, 2001). The fish event horizon marked a relatively sudden and widespread rise in

the consumption of sea fish. The rise was associated with increased fishing of inshore waters along with the beginnings of long-distance trade of cod (*Gadus morhua*, Gadidae) from northern Norway and herring (*Clupea harengus*, Clupeidae) from the Danish straits of the Baltic (Enghoff, 1999; Orton et al., 2014). The fourth and fifth steps were characterized by the widespread *industrialisation* and *computerisation* of the fisheries, which led to rapid increases in landings (Engelhard et al., 2016; Roberts, 2007). While the first, fourth and fifth steps are clearly identified and relatively well understood, the intermediate second and third steps in the development of European commercial fisheries are less well known. Better knowledge of these two periods and the levels of extractions during them is necessary to fully understand the longer-term human impact on the oceans.

Our findings lead us to define the second and third steps of accelerated marine extractions by a rate of increase in landings above demographic growth. The Early Modern Age, c. 1500–1800 (Hutton, 2015), was an era when perceptions of witchcraft led to moral panic, when animals were arraigned before courts and prosecuted, and when frightening sea monsters were present in the psyche of seafarers. However, it was also a time when mariners built the fisheries to a new level of economic and nutritional importance. We validate the concept of the Fish Revolution to capture the phenomenal rise of sixteenth-century offshore fisheries (Holm et al., 2019), and we identify a trajectory of fish catches through the next two centuries that indicate the impact of climate and human demographic change. We propose that comparative understanding of the phases of fisheries history may benefit from distinguishing between *Marine Event Horizons*, such as the archaeologically defined eleventh-century expansion of marine fisheries, and *Accelerated Marine Extractions*, such as identified in the sixteenth-century Fish Revolution, in the eighteenth-century expansion of commercial fisheries, and indeed in the nineteenth-century expansion of trawling.

Much confusion about the Early Modern fisheries arises from preconceptions and the general lack of comparative quantitative evidence. It is sometimes assumed that medieval fish consumption was high due to the ban on eating red meat on 120–150 days of the year. On the contrary, it is frequently taken for granted that the fishing power of sailing boats with longlines and net gear was minimal. Some historians, geographers and marine scientists have ventured estimates of single fisheries (Coull, 1972, 1996; Cushing, 1988; Sahrhage & Lundbeck, 1992). Their estimates of historical herring fisheries are patchy both as regards regions and time periods covered, and they vary considerably. Nevertheless, these figures sometimes get cited for want of better.

In fact, the importance of fisheries for early modern Europe remains mostly unknown. The recent authoritative *Cambridge World History* makes no more than passing reference to the fisheries (Marks, 2015). In the 1977 *Cambridge Economic History of Europe*, Michell observed that "One reason why the definitive history of European fishing has yet to be written is that quantitative records concerning fishing pre-1750 are few" (Michell, 1977). Despite the lack of comprehensive statistics, Michell identified a high point of landings in the sixteenth century, followed by a widespread decline in the following century. He noted that there was likely a complex mix of environmental, economic, political and cultural factors involved in this decline and that the way forward should be to develop better quantitative observations and assessments. Wubs-Mrozewicz (2009) similarly noted that given the lack of quantitative data, the causative influence of supply, demand, culture and politics remains obscure.

Despite the lack of attention by mainstream historians, scholars have identified and published many quantitative records of North Atlantic, North Sea and Baltic Sea fisheries in the last 30 years (Poulsen, 2010). Major publications include the studies of the quantitative records from the Newfoundland fishery by Pope (1995, 2004, 2006) and Rose (2004, 2007) and of the Dutch herring fishery by Poulsen (2008) and van Bochove (2004). Studies of Icelandic and Norwegian cod fisheries were published by Jónsson (1994) and Øiestad (1994). However, the studies differ in quantitative methodology and critical evaluation of the evidence. There is yet no clear assessment of the development in Britain, Ireland and France (Pavé, 2009; Robinson, 2009; Villiers & Borde, 2009). Recent multi-volume syntheses of fisheries history have refrained from systematic quantification (Kolle, 2014; Starkey et al., 2009). Therefore, a comprehensive assessment of the European fisheries must overcome the challenge of quantifying the scale of the historical commercial fisheries according to a common standard. Different measurements may be used to inform distinct questions. The ecologist will typically need to know direct catches and ideally also catch effort, while historians will be more concerned with what was brought back to port and, indeed, marketed. Pope (1995) was the first to alert biologists and historians that their assessment of historical cod extractions on the Grand Banks seriously underestimated catches and suggested that the "question lurking [...] is when humans become a force of nature".

Based on the published literature, we have previously argued that the sixteenth century saw the beginning of a massive increase in North Atlantic fisheries that turned cod from being a high-priced, low-volume commodity to a low-priced, high-volume commodity.

We suggested that this intermediate event may be usefully termed the "*Fish Revolution*" (Holm et al., 2019). We have since provided a revised estimate of Newfoundland and Grand Banks catches of cod between 1675 and 1790. This study was based on new data from French notarial and census records and a full audit of published English admiralty data. We introduced a new interpolation approach called the *capacity trend method* to enable us to fill gaps in the existing time series (Nicholls et al., 2021). The findings documented that Cadigan and Hutchings (2002) and Rose (2004, 2007) significantly underestimated catches and present an erroneous trajectory that cannot be used to understand cod population dynamics.

2 | DATA AND SUPPORTING INFORMATION

This paper presents calculations of 25 fisheries across the North Atlantic from 1520 to 1790, almost covering the full extent of the Early Modern period. We have identified archival information beginning around 1520 for major commercial fisheries of Northern Europe and North America. We conclude the review in 1790 when the impact of the French Revolution and subsequent Napoleonic Wars brought many fisheries to a temporary standstill and upended the bureaucratic reporting on which we rely for our findings.

Here, we present estimates of North Sea extractions of herring and North Atlantic extractions of cod. By the turn of the nineteenth century, these were the main commercial fisheries for the European market. In 1903, the first year of modern European fisheries data, out of total landings amounting to 1,645,476 t, 41% or 676,565 t was herring and 23%, 377,557 t, was cod (ICES Historical Landings 1903–1949, 2014). In the Northwest Atlantic, the first modern statistics are available from 1912 onwards. These include catches for Canada's east coast (excluding the then British Dominion of Newfoundland and catches made by foreign vessels). Cod was 50% (312,651 t) of total landings, herring and sardines 33% (212,022 t) while other species amounted to 17% (103,854 t) (Morse, 2001). We show that cod and herring catches were just as important in earlier centuries. Our review of herring data includes an update on estimates of herring landings previously published by Poulsen (2008): we extend the documentation to cover the Flemish fishery 1480–1600, provide new evidence for the English, Irish and Scottish fisheries, and substantially raise the estimate of the eighteenth-century Bohuslän fishery off southwest Sweden. Our assessment of the Atlantic cod fisheries significantly revises published regional estimates by Jónsson (1994) for Iceland, Øiestad (1994) for Norway and Rose (2007) for Newfoundland, and for the first time provides estimates for the Faroes, Shetland, France, Scotland and England.

We have reviewed and revised the published findings while following the methodological principles outlined below. In addition, we have conducted original archival research as detailed in the Appendices. We distinguish between data derived from historical observation and imputed values. Some data are available as contemporary observations in the form of serial annual data for one or more centuries, while for others, directly observed evidence is only available as single patchy data points. A total of 6,775 data points were analysed, accounting for annual values for the period 1520–1790. Twenty-five different fisheries were identified, with a clear differentiation between the West Atlantic and the East Atlantic. 39.1% of this data coverage was provided from archival and related sources, either directly or following basic conversion processes to conform to metric tonne measurements. Some 60.9% of the values were trended, interpolated or extrapolated, primarily based on observed ecological correlations using capacity trended values from related or comparable fisheries, thus allowing the *softening* (more closely complementing the trends of other related fisheries) of simple linear interpolations to match actual values more accurately. We have imputed data points by assuming linear catch tonnage growth rates for gaps of up to 20 years; however, whenever possible, we have assessed total extractions using the capacity trend method (Nicholls et al., 2021). In some of the series, this still left us with blanks for the early years. In these cases, we have made the best possible estimates as detailed in the Appendices, amounting to between 1.5% and 25% of landings for these fisheries. In some cases, there is good documentation to show that the absence of data represents none or practically no fishing activity. This is the case for 186 years of the Bohuslän herring series, the German North Sea series (172 years) and extremely likely for the cod fisheries of the Dutch Icelandic (141 years), Spanish/Spanish Basque Newfoundland (150 years) and Portuguese Newfoundland (151 years). This means that for the full range of 25 series across 270 years, we want to fill positive information in 5,950 data cells. Data coverage for the thirteen cod series is 36.1%, and for the twelve series of herring fisheries, 42.5%.

Values and percentages for each of the twenty-five data sets are provided in three distinct tranches, which enable clear distinctions between source-based reported data, data based on sources that have had some level of calculation included (incorporated), and data that are calculated from trends or estimated:

- *Given data*—actual reported data from stipulated sources incurring minimal conversion to metric tonnes. These data are regarded as reliable and, wherever possible, they have been corroborated using two or more sources (1,187 total, 673 herring, 514 cod).
- *Incorporated data*—data with some level of calculation and conversion to metric tonnes. Typically, these data are based directly on at least some given data points within the same occurrence and are regarded as reliable (1,515 total, 758 herring, 757 cod).
- *Trended, Interpolated or Extrapolated data*—these data are obtained through calculation, informed estimates and/or using the Capacity Trend Method (Nicholls et al., 2021). Wherever possible, they are based on the last, nearest known given data points and plotted against similar fisheries to reflect trends in fishing effort (4,123 total, 1871 herring, 2,252 cod).

Given data and Incorporated data are jointly regarded as providing a good overview of the annual values of caught and/or landed fish per annum, these are regarded as positive information. The values of trended, incorporated and extrapolated data that were determined applying the capacity trend method (Nicholls et al., 2021) are 38.3% for herring and 41.7% for cod.

The appendices list the compiled data sets and the supporting documentation and include online links to the individual data and documents. All data and documents are made freely available in the public domain. Tables are provided in the Data Availability Statement that also enable online access links to the data and documents. The necessary detailed explanations of provenance, source materials, references, nature of records, the extent of coverage, calculations, conversions and applied methodologies are contained in these documents. We provide all our data in an online, open-access format that summarizes the data sets and provides statistical information (Holm et al., 2021, http://doi.org/10.6084/m9.figshare.13614452). Each individual data set is linked from this downloadable spreadsheet, which is available in a proprietary Excel format, or in the public domain Open Office format. We have made all data publicly available following the Darwin Core schema (OBIS, 2017), ensuring the inclusion of relevant data fields that are pertinent and necessary for the discovery of the information provided here. Future online updates are enabled and transparent as all data are individually time-stamped, and data sets are versioned based on any applied modifications. The analytical steps taken to convert archival data to live weight tonnages are explained in the Supporting Documentation.

3 | METHODS

The geographical extent of the study was primarily determined by data availability. Historically, herring and cod have been fished by peoples all around the North Atlantic rim. We have identified quantitative data of extraction for the North Sea herring fishery (including Danish, German, Dutch, Flemish, French, English and Scottish fisheries), the waters around Ireland and off the west coast of Norway, For the cod fishery of the North Atlantic, data are available for the Norwegian, Faroese and Icelandic home fisheries as well as distant water fisheries off Iceland and Newfoundland by French, English, Dutch, Spanish (incorporating Spanish Basque) and Portuguese fleets. We are confident that the data include the main areas of cod and herring fishing during the period 1520–1790. We have included the extremely limited data available for the Baltic herring fishery, which was highly significant in the sixteenth century, but we have not estimated the Baltic cod fishery, which was quite limited during the period (MacKenzie et al., 2007).

Ideally, catches—what is directly extracted from the sea—should be measured in live or wet weight, that is the weight of fish ungutted and with a complete skeleton, including the head. Such direct measurement is extremely rare in pre-scientific sources, although a recalibration of measurements is often possible. We have recalculated historical extraction and market values to a standard of metric tonnes (t) live weight (weight before processing such as decapitation, gutting and drying) and critically evaluated the evidence for bias, inconsistencies and the thoroughness of original data collection. Details of these procedures, calculations and explanations are provided in the Supporting Documentation that is referenced and linked in the Appendices; each identified fishery is linked to an individual data set and a supporting document. The extent of smuggling will remain unknown to some degree: however, a study by Jones (2012) of the trade to Bristol, southwest England, indicates that smuggling of bulk commodities, such as fish, occurred only to a limited degree due to low or non-existent tariffs.

We assume that historical identification of the herring and cod species was consistent as regional control was enforced in the European markets to enable customer confidence. The discerning quality of the market is clear from the ban on selling Shetland cod alongside Norwegian cod (both *Gadus morhua*) (Wubs-Mrozewicz, 2009) and the price difference between Flemish and Baltic herring (both *Clupea harengus*) (Unger, 1978). The distinction served to identify products of different cures.

Fish was often sold individually or by numbers such as the Danish ol (80), kast (4) or vorde (10). While such numbers are straightforward, a hundred denoted a "long hundred" of 120 throughout nearly all Northern Europe. Weights, measures and numbers varied by region and city and conversion to the metric system is cumbersome. In general terms, herring was overwhelmingly sold by the barrel. While the number of fish per barrel varied due to differences in fish sizes, container volumes were regulated; therefore, tonnages can be calculated.

Discard remains an unknowable entity but is unlikely to have been a major factor in the cod and herring fisheries. Hooks attracted only cod of a size that could manage the bait while the predominant method for catching herring, the drift net, targeted schools of herring of sufficient size to be caught in the mesh. However, it is vital to consider how much was consumed locally rather than being put on the market. The share of catches that went directly for the family's own consumption, and probably some barter trade, will have been sizable, and we have endeavoured to estimate domestic consumption based on available contemporary historical observations as detailed in the Supporting Documentation of each fishery where relevant. Own consumption also includes what was eaten on board which remains unknowable (although upper bounds could be estimated).

Estimates of landings require a detailed understanding of exactly what was measured and reported in the historical documents and an understanding of the economic, technological and social parameters. Total extractions include marketed landings, discard at sea, and non-marketed consumption by fishers and their families, as well as, what was distributed outside the market (such as gifts or exchanges). For the evaluation of the historical pre-scientific records, we use the following terms:

- Catches—in historical documents will often refer only to that part of the extractions which was considered useful in terms of marketed landings. Catches may or may not include fish

consumed on board or brought away for non-market use on land. This type of information is relatively rare.

- Landings—what fishers brought back to port. Such information is frequently available in medieval and early modern records. The weight reported will often be of fish in a semi-processed stage, sometimes gutted, maybe lightly salted and beheaded. When we calibrate such values to calculate live weight, it is important to understand the actual processing of the product to perform valid conversions.
- Marketed weight—landings except for waste and what was taken out for the fisher's own consumption. The marketed weight will often be known as dry weight of fully processed fish, gutted, dried or salted. It is important to account for the weight of packaging and brine.
- Export values—the share of marketed landings that were sold out of the country. This is often the only known value and, in such cases, it is crucial to try to establish the export ratio of total catches.

The ratio of marketed to non-marketed landings varied over time and social context, so it is important to establish degrees of commercialisation. Conversely, we only have export values for some fisheries and need to calculate total landings based on available evidence for home consumption. This paper reviews the evidence for the major supply regions for cod and herring derived from serial records, typically, originally collected for commercial, tax or regulation purposes. The purposes for data collection vary by region, but by assessing the evidence against the criteria outlined above, it is possible to calibrate for these differences and compare like with like. A typical example may be found in the Faroe Islands Cod Landings as detailed in the Supporting Documentation (https://doi.org/10.6084/m9.figshare.14260844). Here, for the period 1709–1807, we find export values supplied from Danish Statistical Records that provide a good series of data. However, these only detail landings that were subsequently shipped abroad. Domestic consumption values had to be factored into the equation to better understand the overall landings per annum. Population statistics coupled with a gross annual consumption per capita value enabled domestic consumption to be calculated and added. The resulting value provided an overall total landing amount.

High-quality herring processing standards were developed by the late Middle Ages, with premium prices paid for branded products (Unger, 1978). Conversion figures from processed to live weight are provided by Helland (1896, pp. 21–26). The cod fishery similarly maintained high artisanal standards (Pope, 2004; Wubs-Mrozewicz, 2009). The fact that discerning merchants and ultimately customers regularly rejected sub-standard products is a solid reason to trust conversion ratios of traded weights into live weight tonnage. The processing of landed fish at small ports, coves and beaches along the east and south coasts of Newfoundland saw cod being cleaned primarily by beheading and gutting, then salted by experienced workers who appreciated the precarious balance between under-salting and over-salting, which led to the fish spoiling early or wasted salt—an expensive commodity. The processed fish was then either laid out on drying racks or hung from lines in the cold, dry air. The resulting dried product lost about 4.7 times its original weight and was more manageable for the long voyage back to European markets, where it fetched good and sustainable prices (Nicholls et al., 2021).

In some cases, bankers were deployed on the Grand Banks to catch fresh cod and spirit them directly back to European markets where they generally attracted better prices than the dried product, but this varied between the French and English in terms of volume. In the French case, freshly caught fish was highly sought after, while English markets were seemingly neutral. This is reflected in the ratios of bankers operating for these two protagonists. The French carried roughly 40% of all their fish in this fresh state, sometimes known as “green” or “wet” denoting the basic processing of beheading and gutting then lightly salted and/or retained in brine (Brière, 1990, p. 20). In the English case, green or wet fish values varied between 1% and 5% of the total (Nicholls et al., 2021).

Geographically, there was a clear distinction between fisheries operating in the Northwest Atlantic and fisheries occurring in the Mid and Northeast Atlantic. The North Atlantic fisheries of the early modern period occurred across thousands of miles, with cod fishing dominating off Newfoundland, Iceland, Faroes and Norway while herring dominated catches in the North Sea (Poulsen, 2008; Starkey et al., 2009). We provide two maps, which tentatively place the primary fishing locations for each herring (Figure 1) and cod (Figure 2) fishery. The numbers on the map correspond to the ID numbers of each fishery. The geographic extent of each fishery is also described in the supporting documentation.

The Northwest Atlantic saw French, English, Spanish, Basque and Portuguese cod fishing efforts spanning the Newfoundland coastal areas as well as the Grand Banks. In the French case, this fishery extended well into the Scotian Shelf and even further inside the Gulf of Saint Lawrence, while the English focussed primarily on the east coast of Newfoundland, extending to the southern Newfoundland coast after the 1713 Treaty of Utrecht and the withdrawal of the French from Newfoundland (Brière, 1985). Spanish and Portuguese fishing efforts were largely carried out in the same manner and with the same geographic focus as the French. Importantly, for this study, while Basque fishing efforts are recognized as a separate entity, they have been included in the values of the Spanish and French data, respectively, to ensure continuity of data—all the protagonists engaged in fishing along the Grand Banks to the south-east of Newfoundland.

The Northeast and Mid-Atlantic saw commercial fishing for both cod and herring through the early modern period. Herring fishing primarily took place along the English North Sea coast during the annual herring migration but extended into the North Sea and other areas like the Channel and the Baltic Sea. The Dutch were the primary actors in the North Sea, but English, French, Flemish and Scottish fishers also engaged in herring fishing (Poulsen, 2008). Scottish fishing took place around the Hebrides and along the west coast of Scotland (Coull, 2003; Holm & Nicholls, 2021). The Danish effort was focussed on the Baltic and the North Sea regions closer to the Danish coast, including the Kattegat and Limfjord (Holm, 2016),

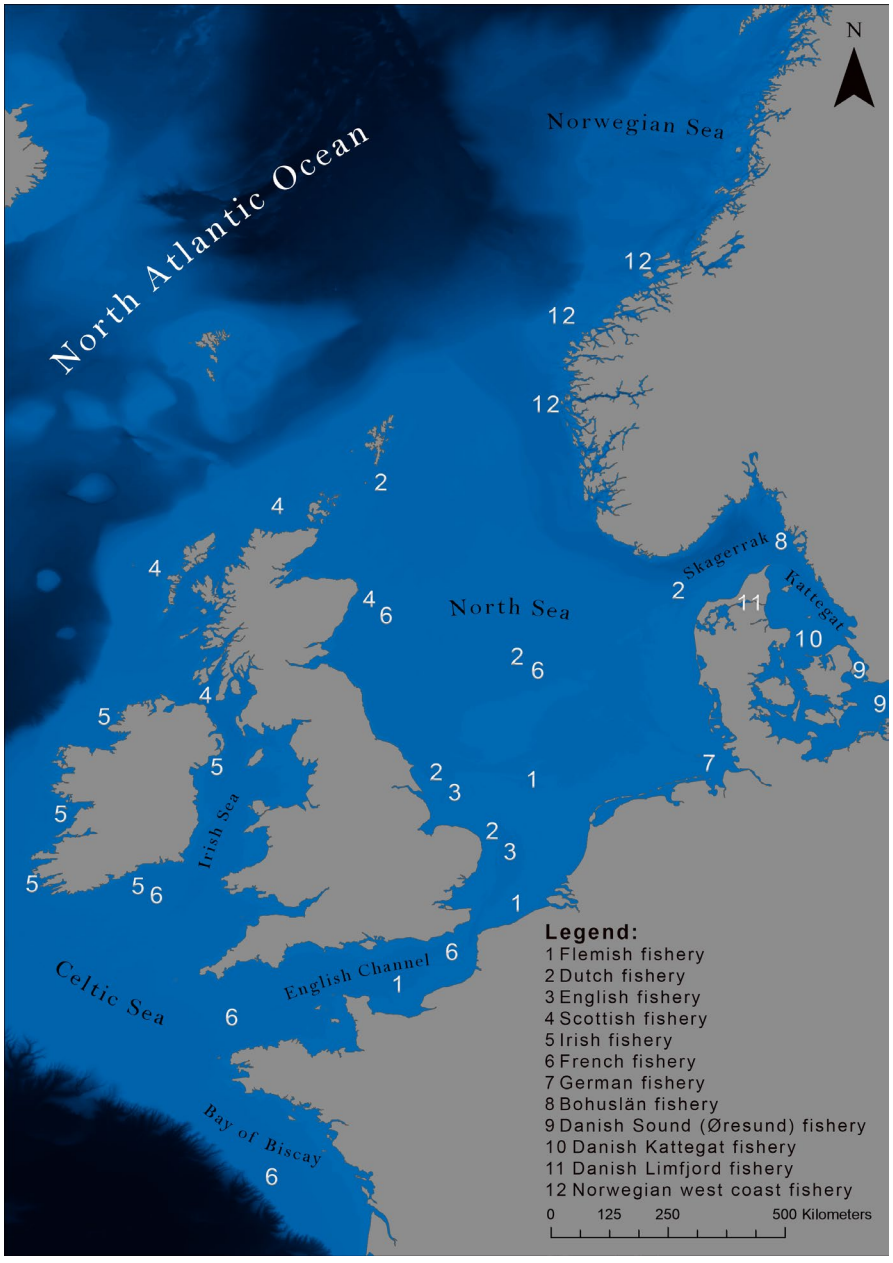


FIGURE 1 Tentative Indication of Herring Fishery Locations, 1520–1790

while the Norwegians were active in the Norwegian and Barents Seas along the Norwegian coast (Kolle, 2014). The Irish herring fisheries operated mainly in the Irish and Celtic Seas (Hayes, 2021). Cod fishing in this region was more widespread than herring, with the waters around Iceland being a significant area of engagement; French, English, Dutch and Danish fishers operated here annually. The Faroe Islanders engaged in activities around the islands alongside various other nations, and Shetland was similarly affected. The largest cod fisheries in this region were conducted in the Barents Seas along the Norwegian coast. The Scottish cod fishery operated primarily along with the Scottish east and west coasts. The North Sea was fished mainly by England, France and the Dutch, but other nations were also present.

The characteristic differences between the two primary species investigated here must be carefully considered in geographic terms, especially where fishing grounds and regions overlap. Typically, in the North Sea, herring were caught during summer and autumn months following their migration down the coast of Britain. On the contrary, cod were often fished during winter and spring (Poulsen, 2008). This differentiation afforded some vessels to "double-dip" and participate in both fisheries to some extent, despite the gear and methods being quite different. Herring fishing was principally carried out using mesh nets to capture volumes of the small fish, while cod fishing was typically carried out using longlines with multiple baited hooks. However, there were also specialist, dedicated fleets that focussed solely on a single species, as in the case of the Dutch herring fleet; their large vessels ("buizen" or "busses") were adapted to maximize net fishing, and herring pre-processing in the North Sea and were supported by carriers that brought barrelled fish back to port as a shuttle service.

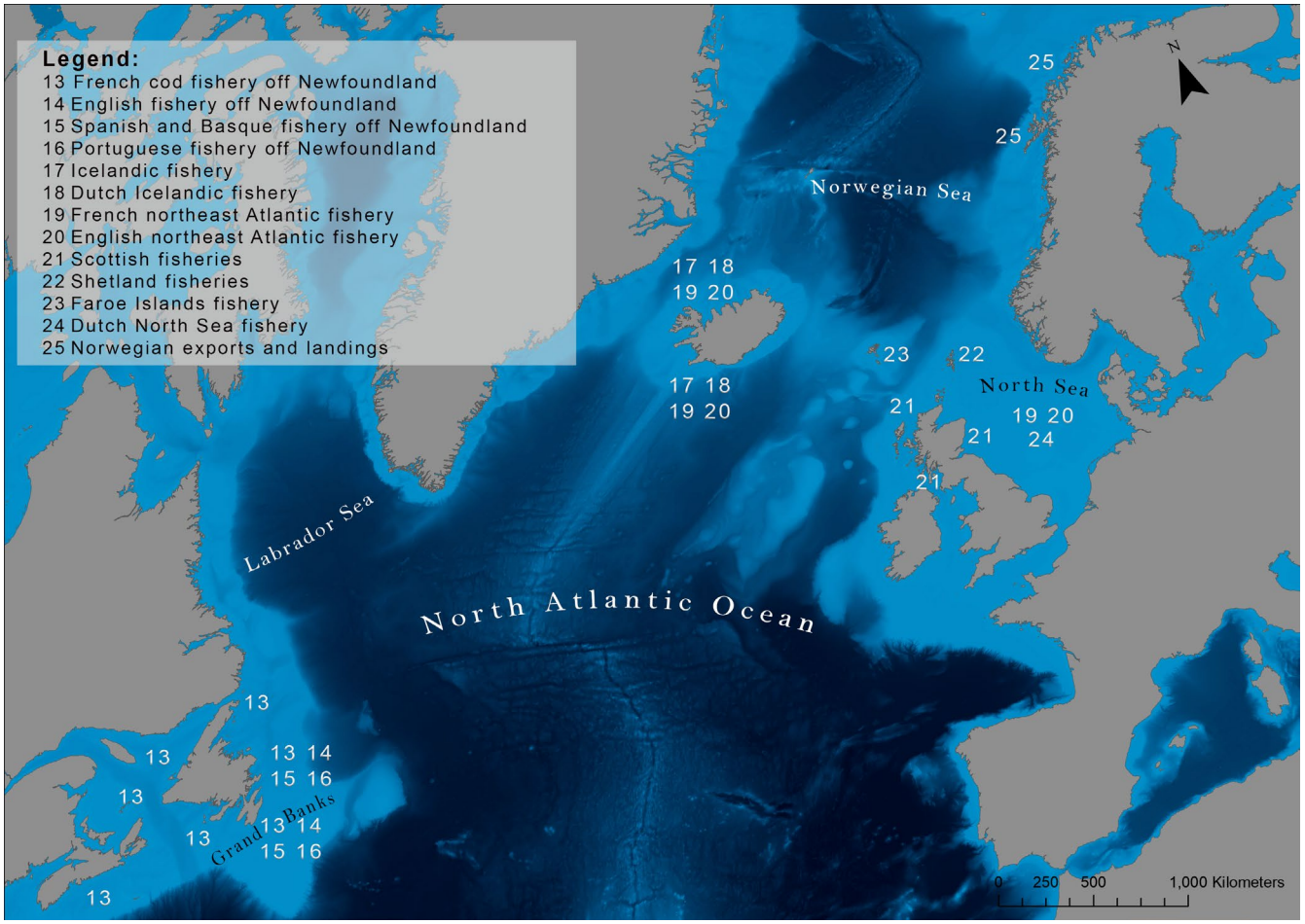
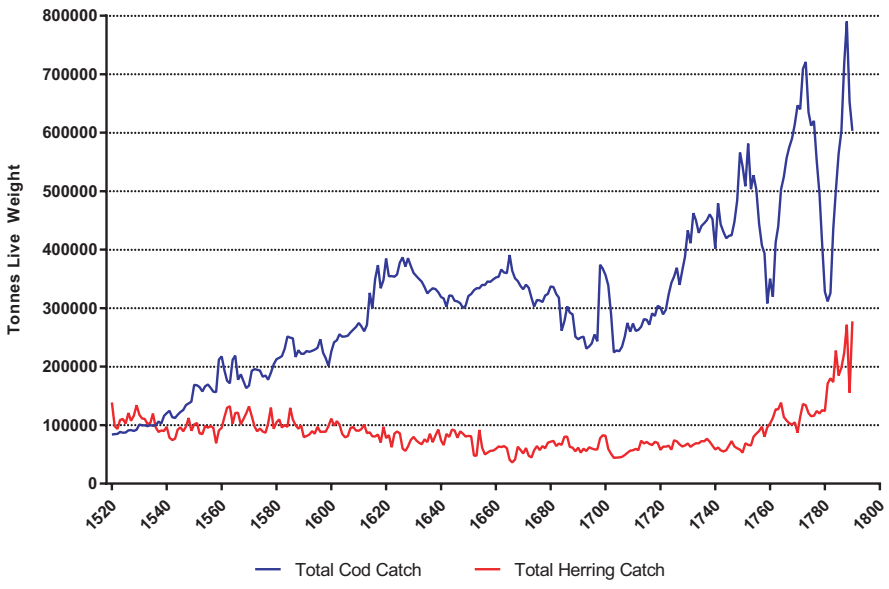


FIGURE 2 Tentative Indication of Cod Fishery Locations, 1520–1790

FIGURE 3 Reconstructed Annual Herring and Cod Catch in the North Atlantic, 1520–1790



4 | RESULTS

The overall picture is one of the growth from 1520 until 1620, stagnation and even decline until 1720, and renewed growth until 1789 when the French Revolution upended established fisheries patterns. We detect two periods of elevated growth during the Early Modern Age, 1540–1620 and again in 1750–1790. Total supplies of cod and herring amounted to over 200,000 t in 1520, rising to nearly half

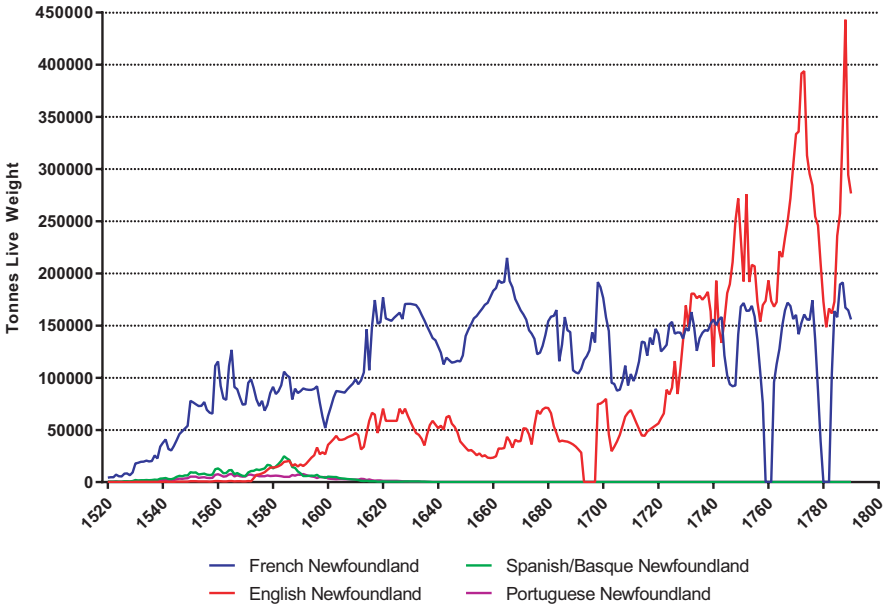


FIGURE 4 Reconstructed Annual Cod Catch in Northwest Atlantic, 1520–1790

a million tonnes by 1620 and exceeding 1 million t by the 1780s. Supplies hit a low between 1680 and 1720 when they amounted to less than 350,000 t in most years.

Herring had been the major species targeted during the Middle Ages, but the Fish Revolution put cod centre stage. By the close of the medieval period, c. 1520, the North Sea herring fishery provided Europe with landings of more than 100,000 metric tonnes. Cod was a close second with landings of about 85,000 t (Figure 3). By 1540, the herring and cod fisheries were of equal size, and in 1560, the cod fishery was double that of the herring. By 1620, the Golden Age of Dutch herring fisheries, catches of cod outweighed those of herring by a factor of four. The relative importance of the two fisheries remained roughly at this level through the eighteenth century.

Cod, then, came to define the Early Modern period. Total cod landings increased nine-fold between 1520 and 1788 from 88,000 to 774,000 metric tonnes, and landings data show an N-shaped pattern (up-down-up) with growth in the sixteenth century until 1620, followed by seventeenth century decline and renewed linear but extremely volatile growth in the eighteenth century.

The cod fisheries developed in two broad regions, the Northeast, and the Northwest Atlantic, with growth much stronger in the *Northwest Atlantic* (Figure 4). The key time of acceleration in the Northwest was the 20 years after 1540 when landings more than tripled from 40,000 t to almost 140,000 t. Northwest landings peaked in 1620 at almost 250,000 t. In the next eighty years, landings only occasionally reached a similar level. The period was characterized by volatility and many years of poor landings of below 200,000 t. A new time of impressive growth rate came between 1705 and 1730 when landings more than doubled from 125,000 t to nearly 320,000 t. Extreme volatility persisted to mar the fishery, but eighteenth-century landings grew to a peak in 1788 of more than 600,000 t. The volatility of the Northwest Atlantic fisheries followed distinct national patterns. The early years of the sixteenth century saw a mix of Spanish, Basque, Portuguese, French and English fishers exploring the opportunities of the fishing grounds off Newfoundland. However, the Iberian landings declined from the 1580s and vanished by 1630. The fishery became dominated by French fishers who returned about two-thirds of all reported landings. The French fishery reached a high point of 170,000 t in 1632. Later, French landings rarely exceeded this level and showed extreme volatility in the next century and a half. The English fishery, on the contrary, was slow to evolve, despite the early start, but by 1600 had reached half the size of the French landings. English landings peaked in 1626 and then declined with a new peak around 1680. By the 1740s, the English overtook the French as the most important fishers.

In comparison, the cod fisheries of the *Northeast Atlantic* (Figure 5) saw slow but relatively steady growth. Landings were stagnant between 1520 and 1580 at around 80,000 t and doubled in the next 40 years to a peak in 1625. Like in the Northwest, the rest of the seventeenth century saw a long-term decline that bottomed out in 1702 at just under 100,000 t. Renewed growth only began in the 1720s to a new level of 155,000 t in the 1760s that was sustained through the next decades with some exceptionally good years towards the end. The most important Northeast Atlantic fishery, the Norwegian, had the strongest growth from 20,000 t in 1520 to a peak of 80,000 t in 1650. It then went into a long decline that was only reversed by the 1730s. Landings tripled in the next 60 years. The other major fishery, the Icelandic, flatlined through the early modern period at around 20,000 t; the comparatively minor Faroese also followed this trend, but with notable volatility. The Scottish and Shetland home fisheries each doubled from around 18,000 t in 1520 to about 40,000 t in 1788. Distant-water fisheries were conducted mainly off the coast of Iceland. The English fishery off Iceland was of some 20,000 t in 1528 but declined and disappeared around 1700. There is sporadic evidence of early Dutch and French fisheries off Iceland, and in the second half of the eighteenth century, they landed about 1,500 t

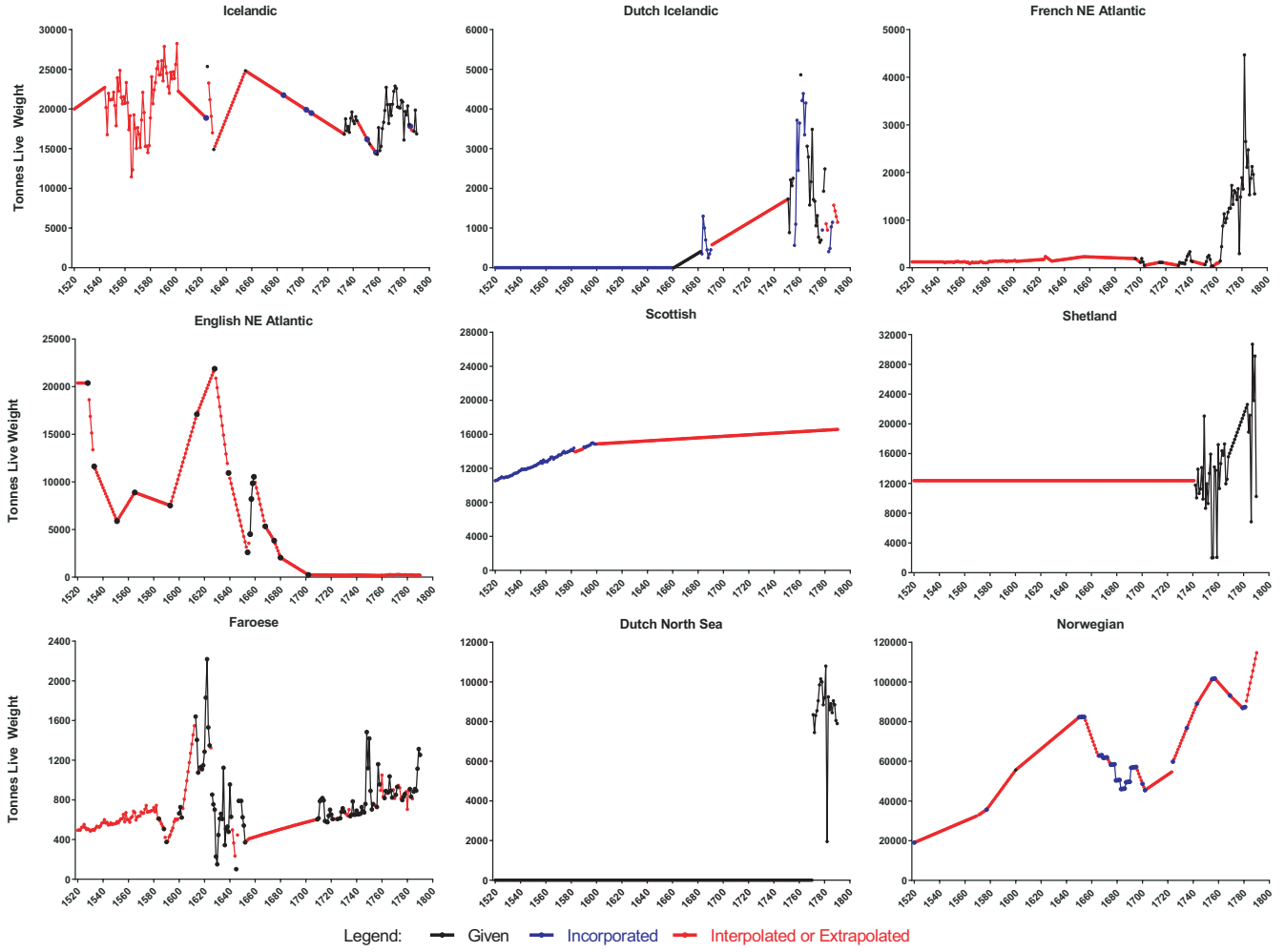


FIGURE 5 Reconstructed Annual Cod Catch, Individual Fisheries, Northeast Atlantic, 1520–1790

each. Interannual variation cannot be identified for the Northeast due to the patchiness of given data.

Herring landings provide a completely different vista (Figure 6). Unfortunately, we do not have data for the Northwest Atlantic herring fishery. Through the sixteenth century, Northeast Atlantic (including primarily Baltic, North Sea and the Irish Sea) landings oscillated at around 100,000 t annually. From c1620, a long-term decline set in, leading to total landings being halved by 1750 to just over 50,000 t. The decline occurred with year-on-year landings varying ±30% on the decadal average. Low points occurred in ten- to fifteen-year intervals (1543, 1558, 1576, 1590, 1605, 1618, 1627, 1641, 1652, 1666 [all-time low], 1673, 1691, 1703, 1720, 1744, 1750, 1770, 1775, 1780).

The herring industry experienced significant geographical shifts in production. In the sixteenth century, landings shifted from the Baltic to the North Sea. The Danish Øresund (Sound) fishery totalled some 60,000 t in the 1520s but declined rapidly, and by the 1580s, the towns that had thrived on the trade lamented its loss (https://doi.org/10.6084/m9.figshare.14258318). The reasons for the decline are unknown. Tax records of the Kattegat fishery near the Øresund document an abrupt decline of fishing effort, which may indicate a change in abundance of nearshore herring (https://doi.org/10.6084/m9.figshare.14258282).

At the same time, the Flemish and Dutch fishery built up a robust North Sea fishery (https://doi.org/10.6084/m9.figshare.14258357, https://doi.org/10.6084/m9.figshare.14258342). By 1,600, the Flemish fishery was effectively closed by the Dutch, who succeeded in taking over the Flemish share of the North Sea. Through most of the seventeenth century, the Dutch industry dominated the market, while landings declined. By the 1650s, the Dutch fishery had been halved, and the decline persisted through the next one-and-a-half centuries to a level of about 10,000 t by the mid-eighteenth century. Dutch supremacy waned after 1650 when Scottish, Irish and later English fisheries supplied some 15–20,000 t annually (https://doi.org/10.6084/m9.figshare.14258432, https://doi.org/10.6084/m9.figshare.14258387,https://doi.org/10.6084/m9.figshare.14258351), followed by increased supplies from the Danish Limfjord around 1700 (https://doi.org/10.6084/m9.figshare.14258306). French landings were strong around 1730, but the single most spectacular fishery began around 1750 when vast shoals of herring began to spawn

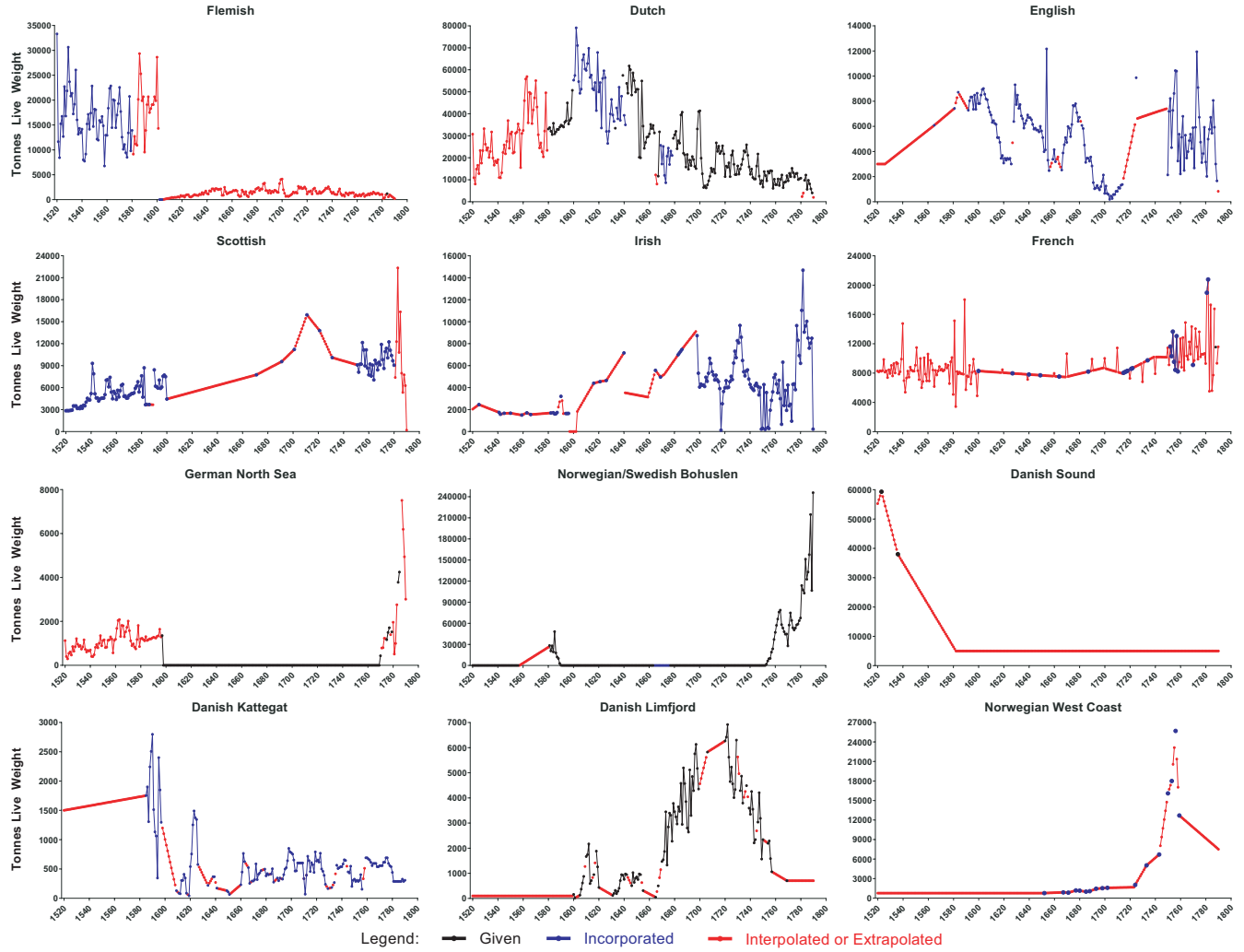


FIGURE 6 Reconstructed Annual Herring Catch, Individual Fisheries, North Atlantic, 1520–1790

in the Skagerrak near the coast of Bohuslän off Sweden (https://doi.org/10.6084/m9.figshare.14258366, https://doi.org/10.6084/m9.figshare.14258408). Bohuslän had seen a brief interval of excellent herring fishery already in the 1560s–1580s, but the experience of the second half of the eighteenth century was of a different order altogether. Landings shot up from a few thousand tonnes by 1750 to 50,000 t by 1760 and reached a staggering 245,000 t in 1790. Such large quantities presented difficulties to merchants who were unable to salt and barrel all of the catch and were forced to cook much of it to train oil in huge fuel-consuming cauldrons.

5 | DISCUSSION

The figures for total landings show that fisheries using pre-industrial technology reached extraction levels far higher than previously assumed by fisheries scientists and historians. To put our findings in perspective, it is helpful to consider the size of North Atlantic fisheries in the early twentieth century, when modern statistics first became available. Northwest Atlantic catches of cod in 1900–1904 averaged 581,113 t (Morse, 2001), and Northeast Atlantic catches in 1903 amounted to 377,557 t (ICES, 2014), a total of 958,670 t. Thus, cod catches in 1788 amounted to 80% of catches at a time when steam trawling had revolutionized fishing. The handline and longlines of traditional cod fishing were clearly very efficient, and total landings increased little by the introduction of steam power and trawl.

In contrast, the 1788 herring landings amounted to only 39% of the 1903 harvest of 676,565 t from the Northeast Atlantic (ICES, 2014). The herring fishery, which depended on drift-netting, seems to have benefitted considerably from the introduction of steam. The increase may have been related to the ability of steam-powered capstans to haul larger nets and extended fishing time as vessels were able to keep longer at sea. Most importantly, twentieth-century operations extended farther north. The early modern herring fishery targeted stocks as they congregated to spawn along the Scottish and English coasts in the summer and autumn before dispersing in the eastern parts of the North Sea to feed in winter and spring (Poulsen, 2008). The Atlanto-Scandian herring stock of the Norwegian-Icelandic Sea played a minor role before the nineteenth century. Norwegian fishers were restricted to inshore catches as they did not have access

to open-sea driftnet technology until the late eighteenth century (Holm, 1995; Kolle, 2014), and Icelandic and Faroese fishers were similarly restricted to seines operated from the shoreline (Starkey et al., 2009). In short, while driftnet technology and sail power constrained early modern herring catches, the simple handlining gear was not an appreciable constraint on the growth of the cod fishery.

The scale of pre-modern cod and herring fisheries underline the conclusion of Pinnegar and Engelhard (2008) that "ecosystems were not pristine before the onset of industrial fishing and it is difficult to assess the "virgin" state of a population given that it may have been subject to moderate or even high levels of fishing mortality for many centuries." Our findings provide essential information for our understanding of the human impact on Life Below Water (United Nations Sustainable Development Goal 14) (UNDP).

The most important human benefit of the second and third periods of elevated marine exploitation was increased food security. Table 1 shows that annual consumption of herring and cod almost doubled during the Fish Revolution of the sixteenth century from 2.9 to 5.7 kg per capita. The amount may be compared with the global average fish consumption of almost 10 kg in 1960, which includes other species as well (Guillen et al., 2019). Access to cheap dried protein will have been critical to food security in pre-industrial societies. Dried or salted fish kept well and was generally cheaper than beef during the spring months when grain and meat stocks ran low (Allaire, 2021). Bacalao (dried/salted cod) came to play a vital role in eighteenth-century Spain, so much so that it provided 15% of animal-based protein (Grafe, 2004, p. 34). In 1785, annual consumption was 3.3 kg of cod per person over 4 years old (Grafe, 2011, p. 85). Figure 7 and Table 1 indicate that increased availability of fish likely played a significant role in the demographic rise of Western Europe (Maddison Project Database, 2020). This finding of the role of marine life in combating hunger is of relevance to the United Nations Sustainable Development Goal 2 (Zero Hunger) (UNDP).

During the early modern period, there was a *geographical* shift in the focus of fisheries from east to west. Herring was increasingly sourced in the North Sea rather than the Baltic, and cod was caught in the Northwest Atlantic rather than the Northeast. The reorientation of geography was of geopolitical significance. The Hanseatic League, led by the city of Lübeck, had dominated the medieval fish trade with Baltic herring and Norwegian cod (Nedkvitne, 2014). In the sixteenth century, the fish trade shifted to Western European powers, primarily the Netherlands (herring) (https://doi.org/10.6084/m9.figshare.14258342) and France (cod) (https://doi.org/10.6084/m9.figshare.14480505).

Warfare and conflicts over access to fishing grounds seem to have been the main constraint on the herring and cod fisheries. The general downturn of landings after the 1620s, lasting into the eighteenth century, is broadly mirrored by a century of European warfare. The downturn happened as Europe was plunged into the Thirty Years War (1618–1648), soon to be followed by repeated Anglo-Dutch and Franco-British wars that were at heart about access to fishing grounds. Warfare at sea was only effectively ended by the Treaties of Utrecht (1713–1714), which secured British control of the Newfoundland fishery (Brière, 1985). While the conflicts drove up prices of fish and thus encouraged some fishers to go to sea, the vagaries of the war caused fishing fleets to be destroyed or pillaged. As a case in point, French Newfoundland landings reflected political development in the homeland: while the French Wars of Religion (1562–1598) caused intermittent interruptions to operations out of some French ports, landings climbed in the first decades of the seventeenth century to a high point in 1633 of 175,000 t. France joined

TABLE 1 Consumption of cod and herring per capita

Year	kg per capita	Year	kg per capita
1525	2.866	1675	3.693
1550	3.952	1700	5.014
1575	3.892	1725	4.389
1600	4.922	1750	5.397
1625	5.263	1775	5.68
1650	3.892		

Note: Population figures for Europe (North, Central and West) (Maddison Project Database, 2020).

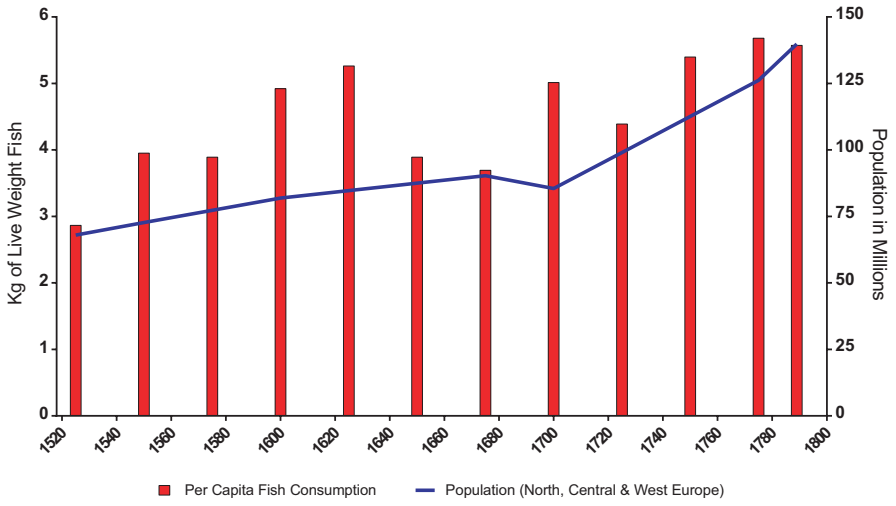


FIGURE 7 Consumption of Cod and Herring Per Capita, Europe (North, Central and West)

the Thirty Years' War in 1635, and landings declined until 1648. In a similar way, the Dutch herring fishery reflected security at sea. In the first half of the seventeenth century, persistent losses of ships to Dunkerque privateers and the English navy forced down the fishing effort (van Vliet, 2003). Later, England forced its way into a dominant position by progressively wearing down the Dutch naval effort during the Anglo-Dutch Wars, which were to a large extent about control over the North Sea herring fishery (Israel, 1995). The rise in British colonial power was reflected in the fishing industry. As the Empire was being built, the fisheries expanded to keep pace with demand. The Newfoundland trade, in particular, evolved into a triangular network of providing high protein food to Iberia and a Caribbean population of migrants and subsumed and enslaved peoples in return for wine and sugar (Pope, 2004). Wars, conflicts and piracy impacted fishing effort directly by taking vessels out of operation and pressing mariners into naval service. Access to fishing grounds might become restricted, and fish carriers might be intercepted en route. The extreme volatility of Northwest Atlantic fisheries can only be understood in this framework of repeated warfare and national rivalries (Rankin & Holm, 2019).

Peace, on the contrary, was clearly associated with a steady rise in fishing effort. The relative peace of the sixteenth and eighteenth centuries allowed European fishers to build and develop the extensive fisheries that constituted the second and third periods of elevated marine extractions. The role of peace and war in pre-modern Europe were not much different from the role of peace and war in twentieth-century European history (Holm, 2013). In view of the scale of cod extractions in the 1780s, the Napoleonic Wars may have brought a similar respite to Newfoundland cod to that of the "Great Fishing Experiments" of World War I and II (Smith, 1994, pp. 158–162; Beare et al., 2010).

Climate change will have been a silent and, at the time unrecognized factor impacting the fisheries. The downturn of North Atlantic temperatures in the second half of the seventeenth century (Brooke, 2014) and increased storminess are likely to have reduced fishing effort (de Kraker, 2005; Sainsbury et al., 2018), while little understood changes in marine productivity, primarily zooplankton, may have impacted stock abundance (Scherer et al., in review). While the volatility of Northwest cod landings is probably best understood in a geopolitical context, the decadal volatility of North Sea herring landings indicates stock fluctuations that may be related to predator/prey relationships (Engelhard et al., 2014). Through the early modern period, while the Northwest came to dominate production overall, there were distinct shifts in the balance of fish production between the Northeast and the Northwest Atlantic. Supplies from Iceland and Norway only accounted for 29% of total production around 1600 and as little as 20% around 1700, while in the best years around 1650 and 1790, Iceland and Norway provided 42% and 30% of the total volume, respectively. Biophysical changes in productivity across the North Atlantic and socio-political circumstances may potentially explain this apparent see-saw phenomenon. Links between climatic variables and long-term abundance fluctuations in cod or herring have been identified based on shorter chronologies (Godø, 2003; Holsman et al., 2012; Toresen & Østvedt, 2000).

6 | CONCLUSION

The lack of quantitative assessment of the early modern fisheries has caused fisheries scientists as well as historians to seriously underestimate the impact of pre-modern fishing effort and total landings of the two main commercial fish species, North Atlantic cod and Northeast Atlantic herring. Our comprehensive review of the data shows that extractions during the early modern period, c. 1520–1790, vastly exceeded previous assumptions. North Atlantic fisheries for cod and herring were of an order of magnitude comparable to industrial fisheries for several centuries before the Industrial Revolution took off. This is a finding that challenges notions of relatively unimpacted marine ecosystems before the Industrial Age.

We identify two periods of accelerated marine extractions (1540–1620 and 1750–1790) when the growth rate of fish landings was higher than human demographic growth. These periods of Accelerated Marine Extraction indicate that fish played an important role in the food supplies of expanding early modern societies. Our findings question assumptions about past human impact on marine animals, especially cod, and provide a basis for research into the scope and scale of pre-modern fisheries.

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DATA AVAILABILITY STATEMENT

All data used in this work to estimate fish extractions are available online. For relevant statistical information and a summary of the data sets, see the spreadsheet: Extractions of North Atlantic Cod and Herring 1520–1790 (http://doi.org/10.6084/m9.figsh

are.13614452). Individual data sets are available as proprietary Excel spreadsheets and as public domain accessible Apache Open Office spreadsheets, and the accompanying Supporting Documents are available as Portable Document Format (PDF) files to ensure public domain accessibility. The individual files are located and accessible in the Norfish Data Collection at: https://figshare.com/collections/Norfish_Data_Collection/5514351. These data may be openly shared, distributed or used under Creative Commons licencing provisions CC-BY 4.0.

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APPENDIX 1

HERRING DATA AND SUPPORTING DOCUMENTATION

Each fishery data set can be distinguished by its ID number (1–25) and title. Figure 1 indicates the tentative locations of where the major fishing grounds of each herring fishing lay. Figure 3 depicts the overall trend of herring catches compared with cod catches in the North Atlantic over the study period. Finally, Figure 6 indicates the reconstructed catches for each individual herring fishery.

1. Flemish herring fishery

Geographical extent: The fishery was primarily conducted off the coast of Flanders, in the English Channel and the southern North Sea from the ports of Oostende, Nieuwpoort and several smaller ports.

Data sources: State Archives of Belgium, Vlietinck (1897, pp. 113–123), Degryse (1961, pp. 43–57).

Data coverage: **24.0**%: 0.4% given, 23.6% incorporated and 76.0% trended; actual data points: 1 given, 64 incorporated and 206 trended, interpolated or extrapolated.

Data set and Supporting Documentation: https://doi.org/10.6084/m9.figshare.14258357

2. Dutch herring fishery

Geographical extent: The fishery was conducted all around the North Sea, predominantly along the eastern British coast from East Anglia to Shetland and occasionally extending into the Skagerrak.

Data sources: College van de Groote Visserij (Netherlands National Archive), van Bochove (2004), Vliet (1994), Poulsen (2008).

Data coverage: **76.0**%: 57.6% given, 18.5% incorporated and 24.0% trended; actual data points: 156 given, 50 incorporated and 65 trended, interpolated or extrapolated.

Data set and Supporting Documentation: https://doi.org/10.6084/m9.figshare.14258342

3. English herring fishery

Geographical extent: The fishery was conducted primarily along the East Anglia coast, and the eastern English coastline to the north and

the south of East Anglia; Great Yarmouth and Lowestoft were the primary ports.

Data sources: English State Papers and Privy Council records (National Archives, SP and PC series), British Library Manuscripts, Butcher (2008), Cushing (1988), Michell (1977), and B. Poulsen (2008, pp. 57–58).

Data coverage: **59.0**%: 0% given, 59.0% incorporated and 41.0% trended; actual data points: 0 given, 160 incorporated and 111 trended, interpolated or extrapolated.

Data set and Supporting Documentation: https://doi.org/10.6084/m9.figshare.14258351

4. Scottish herring fishery

Geographical extent: The Scottish fishery extended around the Scottish coastline incorporating the North Sea, the Celtic Sea and the Atlantic Ocean.

Data sources: Customs records of export trade up to 1604 supplied by Rorke (2001), Hitzbleck (1971, pp. 54–55) who used the Danish Sound Toll Records to analyse Scottish exports to the Baltic, and B. Poulsen (2008, pp. 54–55) who calculated total exports 1600–1800; Tyson (2001) provided demographic values for Scotland.

Data coverage: **41.7**%: 0.0% given, 41.7% incorporated and 58.3% trended; actual data points: 0 given, 113 incorporated and 158 trended, interpolated or extrapolated.

Data set and Supporting Documentation: https://doi.org/10.6084/m9.figshare.14258432

5. Irish herring fishery

Geographical extent: The Irish fishery extended into the Irish Sea, the Celtic Sea and the Atlantic Ocean.

Data sources: Customs records and export volumes from Flavin and Jones (2009), Condon and Jones (2016-2019), Lewis (1927), Mahaffy (1900–1905), Woodward (1999), Mahaffy (1900–1905), Walsh et al., (2018) and First Report of the Commissioners of Inquiry into the State of the Irish Fisheries with the Minutes of Evidence and Appendix (1837). Demographic data from Gillespie (1991) and Cullen (1975).

Data coverage: **44.3**%: 0.0% given, 44.3% incorporated and 55.7% trended; actual data points: 0 given, 120 incorporated and 151 trended, interpolated or extrapolated.

Data set and Supporting Documentation: https://doi.org/10.6084/m9.figshare.14258387

6. French herring fishery

Geographical extent: The French fishery was primarily conducted along the English Channel, in the North Sea, the Scottish coastal areas and the Irish Sea.

Data sources: Dardel (1941) conducted a survey of the accessible sources and a fair view of the French catches. Another study conducted in 1788 documented a total of 330 herring vessels, mostly fishing in the English Channel (Poulsen, 2008, p. 68).

Data coverage: **8.9**%: 0.4% given, 8.5% incorporated and 91.1% trended; actual data points: 1 given, 23 incorporated and 247 trended, interpolated or extrapolated.

Data set and Supporting Documentation: https://doi.org/10.6084/m9.figshare.14258366

7. German herring fishery

Geographical extent: Fishing was conducted along the German coast from Hamburg to Emden and into the North Sea.

Data sources: B. Poulsen (2008, pp. 61–63). From 1598 to 1769, there was a known period of inactivity (zero recorded catches).

Data coverage: **66.4**%: 66.4% given, 0.0% incorporated and 33.6% trended; actual data points: 180 given, 0 incorporated and 91 trended, interpolated or extrapolated.

Data set and Supporting Documentation: https://doi.org/10.6084/m9.figshare.14258369

8. Bohuslän herring fishery (Norway/Sweden)

Geographical extent: The fishery was conducted in inshore waters, primarily between the skerries of the Bohuslän coast.

Data sources: Customs records (Sound Toll Records) of Baltic export trade: Holm (2003). Export values and observations of practices for salting and train oil production: Nilsson (1963). Values include periods of known inactivity (Zero recorded catches): 1520–1556, 1591–1663 and 1677–1752.

Data coverage: **91.1**%: 86.3% given, 4.8% incorporated and 8.9% trended; actual data points: 234 given, 13 incorporated and 24 trended, interpolated or extrapolated.

Data set and Supporting Documentation: https://doi.org/10.6084/m9.figshare.14258408

9. Danish Sound (Øresund) herring fishery

Geographical extent: The medieval and early modern herring fishery was conducted in the Øresund and extended to the Baltic islands of Møn, Falster and Lolland. About a quarter of all landings were traded at the fair of Falsterbo.

Data sources: Falsterbo market records, Krabbe (1836), Holm (2016), Weibull (1966), Schäfer (1887). For the period 1582–1790, a conservative estimate of 5,000 t has been assumed each year as no other data are available and no clear trend could be obtained from similar fisheries.

Data coverage: **0.7**%: 0.7% given, 0% incorporated and 99.3% trended; actual data points: 2 given, 0 incorporated and 269 trended, interpolated or extrapolated.

Data set and Supporting Documentation: https://doi.org/10.6084/m9.figshare.14258318

10. Danish Kattegat herring fishery

Geographical extent: The reported fishery extended into the southern Kattegat some 4–6 miles offshore along the North Sjælland coast from Elsinore to Isefjord.

Data Sources: Tax records (oar tax) published by Frandsen and Jarrum (1992).

Data coverage: **54.6**%: 0.0% given, 54.6% incorporated and 45.4% trended; actual data points: 0 given, 148 incorporated and 123 trended, interpolated or extrapolated.

Data set and Supporting Documentation: https://doi.org/10.6084/m9.figshare.14258282

11. Danish Limfjord herring fishery

Geographical extent: The fishery extended from the mid-section of the Limfjord around Nibe to the eastern opening of the fjord into the Kattegat.

Data sources: Sales records (kongekøb) and customs records of domestic and export trade. A series of the King's privileged purchase of herring from the seventeenth century from Christensen (1977) and single years of export data from Blomberg (1933); B. Poulsen (2008, pp. 64–65); Poulsen and Christensen (1990). For the period 1770–1790, a conservative estimate of 706 t (based on the given value for 1769) has been assumed each year as no other data are available and no clear trend could be obtained from similar fisheries.

Data coverage: **36.5**%: 36.5% given, 0.0% incorporated and 63.5% trended; actual data points: 99 given, 0 incorporated and 172 trended, interpolated or extrapolated.

Data set and Supporting Documentation: https://doi.org/10.6084/m9.figshare.14258306

12. Norwegian West Coast herring fishery

Geographical extent: Fishing was conducted inshore on the Norwegian coast between Stavanger and Trondheim on Atlanto-Scandian spring-spawning herring.

Data sources: Customs records of export trade published by Fossen (1979) were converted and recalculated by the authors. For the period 1520–1651, a conservative estimate of 770 t (based on the given value for 1652) has been assumed each year as no other data are available and no clear trend could be obtained from similar fisheries.

Data coverage: **6.3**%: 0% given, 6.3% incorporated and 93.7% trended; actual data points: 0 given, 17 incorporated and 254 trended, interpolated or extrapolated.

Data set and Supporting Documentation: https://doi.org/10.6084/m9.figshare.14258414

APPENDIX 2
COD DATA AND SUPPORTING DOCUMENTATION

Figure 2 indicates the tentative location of each cod fishery. Figure 3 illustrates the overall trend of cod catches in the North Atlantic compared with herring catches over the study period. Figure 4 shows the catches in the Northwest Atlantic cod fisheries, and Figure 5 depicts the catches from individual fisheries in the Northeast Atlantic

COD FISHERIES—NORTHWEST ATLANTIC

This ocean region includes the dominant Newfoundland fisheries, the Grand Banks and areas surrounding Newfoundland.

13. French cod fishery off Newfoundland

Geographical extent: Grand Banks, South and West Newfoundland, Gulf of Saint Lawrence, and Acadia.

Data sources: Notarial records, Census of vessels. The scale of landings by French fishers has been established by Nicholls et al., (2021).

Data coverage: **95.2**%: 54.6% given, 40.6% incorporated and 4.8% trended; actual data points: 148 given, 110 incorporated and 13 trended, interpolated or extrapolated.

Data set and Supporting Documentation: https://doi.org/10.6084/m9.figshare.14480505

Note: While French Basque fisheries operated separately, they are recorded together with the general French values for the purposes of data continuity in this work. French Basque values are based primarily on Basque voyages from the French Basque country, Bordeaux or La Rochelle. Notably, the Spanish Basque region values are recorded with the Spanish values.

14. English cod fishery off Newfoundland

Geographical extent: Grand Banks, North and East Newfoundland, including South of Newfoundland after 1713 (ceded by France).

Data sources: Assorted primary archival and published estimates (pre-1675); Colonial Office censuses of vessels [TNA CO 1] (post-1675). The scale of landings by English fishers has been established by Nicholls et al., (2021).

Data coverage: **38.4**%: 17.7% given, 20.7% incorporated and 61.6% trended; actual data points: 48 given, 56 incorporated and 167 trended, interpolated or extrapolated.

Data set and Supporting Documentation: https://doi.org/10.6084/m9.figshare.14401181

15. Spanish and Basque cod fishery off Newfoundland

Geographical extent: Southern Newfoundland coastal areas, Grand Banks.

Data sources: Regional notarial records; Insurance records (Burgos); Assorted archival records. Spanish and Basque values were combined to provide the series. The scale of landings by Spanish and Basque fishers has been established by the authors of this study, see accompanying data set (Ivinson and Nicholls 2020).

Data coverage: **58.7**%: 3.3% given, 55.4% incorporated and 41.3% trended; actual data points: 9 given, 150 incorporated and 112 trended, interpolated or extrapolated.

Data set and Supporting Documentation: https://doi.org/10.6084/m9.figshare.14258486

Note: While the Spanish and Basque fisheries operated separately, they are recorded together for the purposes of data continuity in this work. Notably, only the Spanish Basque region is included in these values. Similarly, French Basque values, based primarily on Basque voyages from the Basque country, Bordeaux or La Rochelle, are incorporated into the French Newfoundland values.

16. Portuguese cod fishery off Newfoundland

Geographical extent: Southern Newfoundland coastal areas, Grand Banks.

Data sources: Assorted archival records and intermittent references (Portuguese and English). The scale of landings by Portuguese

fishers has been established by the authors, see accompanying data set (Ivinson et al., 2020).

Data coverage: **56.1**%: 0.7% given, 55.4% incorporated and 43.9% trended; actual data points: 2 given, 150 incorporated and 119 trended, interpolated or extrapolated.

Data set and Supporting Documentation: https://doi.org/10.6084/m9.figshare.14258504

COD FISHERIES—EAST ATLANTIC

This ocean region includes The Norwegian Sea, North Sea, the Iceland Shelf and Iceland Sea, the Faroe Plateau and surrounding areas.

17. Icelandic cod fishery

Geographical extent: The fishery was conducted all around the Icelandic coast, predominantly in the inshore waters of the Southwest, West and Northwest.

Data sources: Customs records of export trade, demographic records. Holm and Nicholls used this information to calculate total Icelandic domestic fishery landings, see (Holm et al., 2021)

Data coverage: **18.8**%: 16.2% given, 2.6% incorporated and 81.2% trended; actual data points: 44 given, 7 incorporated and 220 trended, interpolated or extrapolated.

Data set and Supporting Documentation: https://doi.org/10.6084/m9.figshare.14260430

18. Dutch Icelandic cod fishery

Geographical extent: The fishery was conducted around the Icelandic coast, the Icelandic Sea and Icelandic Shelf—it does not include Dutch North Sea fishing.

Data sources: Dutch Annals, Icelandic Annals, lists of vessels published by Simon (1935). Holm and Nicholls used this information to calculate total landings, see accompanying data set (Holm et al., 2021).

Data coverage: **67.9**%: 7.7% given, 60.1% incorporated and 32.1% trended; actual data points: 21 given, 163 incorporated and 87 trended, interpolated or extrapolated.

Data set and Supporting Documentation: https://doi.org/10.6084/m9.figshare.14260499

19. French Northeast Atlantic cod fishery

Geographical extent: The fishery was conducted around the Icelandic coast, the Icelandic Sea and Icelandic Shelf and includes incidental North Sea fishing.

Data sources: de la Villemarqué (1995) published catch data from 1696 onwards, before 1696, values were based on trended Iceland domestic fishery values. Holm and Nicholls (2021) calculate total landings based on this information, see accompanying data set. The statistics relating to Dunkirk, the most active French port in the Iceland fishery, only begin in 1649 when the city was captured by the French; prior to this it was a Flemish port (Duinekerke).

Data coverage: **20.3**%: 20.3% given, 0% incorporated and 79.7% trended; actual data points: 55 given, 0 incorporated and 216 trended, interpolated or extrapolated.

Data set and Supporting Documentation: https://doi.org/10.6084/m9.figshare.14260655

20. English Northeast Atlantic cod fishery

Geographical extent: The fishery was conducted around the Icelandic coast, the Icelandic Sea and Shelf, and the North Sea.

Data sources: Vessel and catch information from State Papers and other national records (Jones, 2000). Additional data points generated by Holm, Ivinson, and Nicholls, see accompanying data set (Holm et al., 2021).

Data coverage: **6.3**%: 6.3% given, 0% incorporated and 93.7% trended; actual data points: 17 given, 0 incorporated and 254 trended, interpolated or extrapolated.

Data set and Supporting Documentation: https://doi.org/10.6084/m9.figshare.14260679

21. Scottish cod fisheries

Geographical extent: North Sea, Celtic Sea, coastal waters around Scotland.

Data sources: Values from Rorke (2001) were used to calculate catches, see accompanying data set (Holm et al., 2021).

Data coverage: **26.9**%: 0.0% given, 26.9% incorporated and 73.1% trended; actual data points: 0 given, 73 incorporated and 198 trended, interpolated or extrapolated.

Data set and Supporting Documentation: https://doi.org/10.6084/m9.figshare.14260736

22. Shetland cod fisheries

Geographical extent: The fishery was conducted in inshore waters all around the Shetland coast.

Observational data: Export statistics as preserved in Custom House Records and published in Goodlad (1971, p. 122). Holm, Nicholls used these values to calculate catches, see accompanying data set (Holm et al., 2021).

Data coverage: **18.1**%: 18.1% given, 0% incorporated and 81.9% trended; actual data points: 49 given, 0 incorporated and 222 trended, interpolated or extrapolated.

Data set and Supporting Documentation: https://doi.org/10.6084/m9.figshare.14260823

23. Faroe Islands cod fishery

Geographical extent: The fishery was conducted in inshore waters all around the Faroese coasts.

Observational data: Tithes records obtained from Zachariassen (1961) and Guttesen (2004) who cite tithe records from which values catch were derived for the period 1584 to 1652. Degn (1929) provided export trade customs records for the period from 1709 to 1790. Missing values were trended from Iceland domestic fishery values. Holml et al., (2019) used this information to calculate total Faroese landings.

Data coverage: **36.2**%: 36.2% given, 0% incorporated and 63.8% trended; actual data points: 98 given, 0 incorporated and 173 trended, interpolated or extrapolated.

Data set and Supporting Documentation: https://doi.org/10.6084/m9.figshare.14260844

24. Dutch North Sea cod fishery

Geographical extent: North Sea

Data sources: Netherlands Central Bureau for Statistics (National Archives s'Gravenhage, 1900 Series 1, pp 328–331) published by Overgaard (2015). Despite the small series, the data confirms that for the Dutch, North Sea fisheries were separately recorded from the Iceland effort. Extrapolated values (trended) prior to 1771 are based on Faroes values, see accompanying data set (Holm et al., 2021).

Data coverage: **7.4**%: 7.4% given, 0% incorporated and 92.6% trended; actual data points: 20 given, 0 incorporated and 251 trended, interpolated or extrapolated.

Data set and Supporting Documentation: https://doi.org/10.6084/m9.figshare.14261054

25. Norwegian cod exports and landings

Geographical extent: The fishery was conducted in inshore waters from mid to north Norway, primarily in the fjords and between islands of Troms and Finnmark.

Data sources: Holm used the Bergen export values and tithes (indicating landings) and records of Lofoten to calculate landings, see accompanying data set (Holm et al., 2021).

Data coverage: **18.1**%: 0.4% given, 17.7% incorporated and 81.9% trended; actual data points: 1 given, 48 incorporated and 222 trended, interpolated or extrapolated data points.

Data set and Supporting Documentation: https://doi.org/10.6084/m9.figshare.14261174